

Geotechnical Documentation for Final Design – Rev. 2

RW 07.15R Temporary Soil Nail Wall

I-405; Renton to Bellevue Widening and Express Toll Lanes Project
Renton, Washington

Prepared for:

Drill Tech Drilling & Shoring, Inc.

2200 Wymore Way

Antioch, CA 94509

This document was reviewed to ensure the design conforms to the requirements of the RFP and is compliant with the design of the permanent construction. The Engineer of Record for this document is responsible for the design and engineering recommendations provided.

I-405, Renton to Bellevue Widening & and Express Toll Lanes Project

DOCUMENT REVIEW

- APPROVED, NO EXCEPTION TAKEN
- APPROVED AS NOTED
- RESUBMIT, REVISE AS NOTED

REVIEWED BY: Todd Wentworth DATE 6 Jan 22

Geotechnical engineering

Review is for general conformance with contract or design documents. Sole responsibility for correctness of dimensions, details, quantities, materials, and safety during fabrication and erection shall remain with the contractor.

This work was prepared by me or under my supervision.



Douglas R. Schwarm, PE
Exp. 29 October 2021



Rev. No.	Date	Description
A	25 March 2021	DTDS Review
0	16 July 2021	Construction
1	30 August 2021	Construction
2	09 December 2021	Construction



9 December 2021

Memorandum



Project: RW 07.15R Temporary Soil Nail Wall

Subject: Geotechnical Documentation for Final Design – Rev. 1

Date: 9 December 2021

This memo supersedes and replaces memos 30 August 21 Geotechnical Documentation and 18 October Developed Bond Strength. This memo also includes data from a recent additional boring drilled by Terracon for FLJV.

~~This revision of the 30 August 2021 Geotechnical Documentation memo includes the discussion from the 18 October Developed Bond Strength memo and includes data from a recent boring drilled by FLJV.~~

Geotechnical Design Parameters

Table 1 summarizes the geotechnical parameters for designing the RW 07.15R Temporary Soil Nail Wall (TSNW), which shores a temporary excavation into the I-405 embankment so earthwork and drilling equipment can access the permanent RW 07.15R foundation. The TSNW is 67 feet long and up to 15.5 feet high.

Table 1 – Geotechnical parameters for TSNW design.

Soil Type	γ (pcf)	ϕ'	Surcharge (psf)	GWT Elev. (ft)	Soil/Grout Bond Strength (Ultimate) (psi)
SM	115	34°	250	42	7.5

The remainder of this memo provides geotechnical documentation for final design according to Section 23.4.2 of the Geotechnical Design Manual (GDM). This geotechnical documentation memo is part of a computations package that includes drawings showing:

- A plan of the existing and planned ground lines, the TSNW alignment, and the borehole locations,
- The TSNW in elevation with boring logs and idealized section, including soil description and properties used for design.
- Sections through the TSNW also showing the boring logs, interpreted section, and design parameters. The critical design section, with engineering parameters noted, appear in the Global Stability computations as well as the construction drawings.

Geotechnical Documentation

Borehole Data Density

On November 29th,
Terracon (for FLJV)

Subsurface data is available from Wood's 30 September 2020 RW 07.15R Geotechnical Engineering Report, which incorporates data from prior investigations. Also, FLJV drilled a borehole in the bond zone behind TSNW 07.15 to satisfy a contract requirement. Figure 1 shows the borehole locations near the TSNW face and in the bond zone.



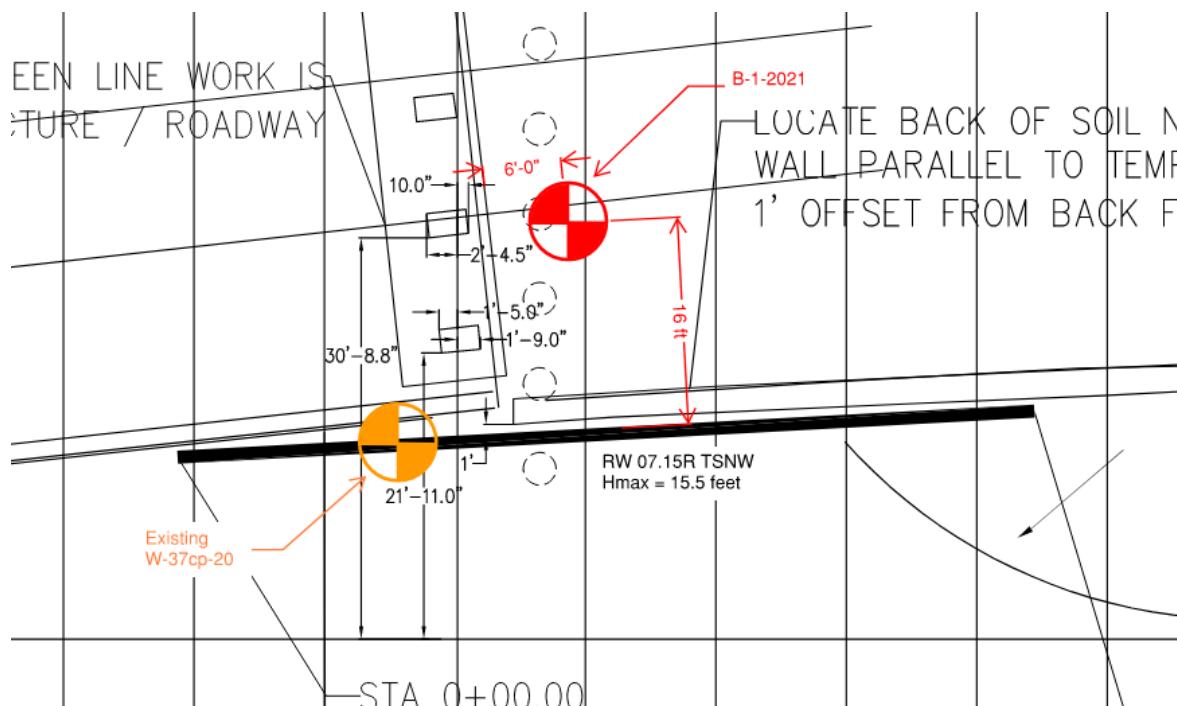


Figure 1 – Borings W-37cp-20 and B-1-2021 relative to the TSNW.

For soil nail walls less than 100 feet long, the GDM requires one geotechnical exploration along the alignment (15-3.4.1) and another in the nail zone behind the wall (15-3.4.2.1). The two boreholes shown in Figure 1 satisfy that requirement.

Soil Stratigraphy

Borings R2B-22vw-17, W-37cp-20, and B-1-2021 show that the TSNW will retain only ESU 1A, loose to medium dense silty sand embankment fill, USCS designation SM. Average SPT blow counts from the face and bond zone boring logs indicate that ESU 1A is slightly denser than at the other boring locations used to characterize ESU 1A at RW 07.15R. There are no notable "soft" spots with excessive fines and/or low SPT blow counts, with the lowest value being 7 blows/ft at a depth close to Row 1 nail elevations. The recent borehole was characterized using the approved geotechnical soil properties methodology. Including the ~~new~~ recent borehole in the ESU 1A soil properties slightly increased average SPT blow counts by about 15% and average WSDOT correlated friction angle by about 2.5%, and the statistical variance for both properties was about 20% lower. For consistency with other designs at this site, the mean minus one standard deviation strength value from the RFU Geotechnical Report is adequate for characterizing ESU 1A behind the TSNW.

Groundwater

The RFU 07.15R Geotechnical Report established a maximum water level of 42 feet at boring R2B-22vw-17. Permanent works at this site design for elevation 40 feet, more than 15 feet



deeper than the bottom of the TSNW. Groundwater is not a significant design concern for the TSNW.

Soil Properties Basis

GDM 15-7.6.2.6 (Jan. 2019) requires the following geotechnical information for soil nail walls:

1. Soil stratigraphy
2. Unit weight
3. Shear strength
4. Surcharge loading
5. Foreslope inclination
6. Backslope inclination
7. Groundwater conditions

Table 2 summarizes these required parameters averaged over the depth interval that the TSNW will interact with the soil. These values are consistent with those provided in Table 6 of the RFU Geotechnical Report.

Table 2 – Engineering soil parameters for embankment fill.

Soil Type	γ (pcf)	$\phi'_{lower,GDM}$	Surcharge (psf)	Foreslope inclination	Backslope Inclination (deg)	GWT Elev. (ft)
SM	115	34°	250	1.5H:1V	0	42

Though not listed in the GDM design input requirements, soil nail bond capacity on the grout/soil interface is an important design parameter. Nails are designed using an ultimate failure capacity of 1.7 kips/ft of nail. This value assumes 6-inch diameter holes, rotary (air) drilling, gravity grouting, and a 7.5-psi bond strength on the soil/grout interface. The selected ultimate bond strength is governed by verification test results, as described in a following section of this memo, consistent with design guidance from Table 4.4a in GEC 7 (FHWA-NHI-14-007, Feb. 2015).

Design Methods

The temporary soil nail wall has been designed using the methods and requirements contained in:

1. WSDOT Geotechnical Design Manual (GDM) M 46-03.12, May 2015, amended with Chapters 6 & 15 January 2019.
2. AASHTO LRFD Bridge Design Specifications 9th Edition, 2020, as required by GDM 15-7.3.2 (Jan. 2019).
3. FHWA Soil Nail Walls Reference Manual, FHWA-NHI-14-007, FHWA GEC 007, February 2015.



addressed and

Figure 1 shows the failure modes for soil nail walls. ~~Drill Tech Drilling and Shoring addressed The Internal Stability and Compound Stability failure modes. Those analyses are summarized in a separate design narrative.~~ Global Stability failure modes, though, consider slopes related to equipment access explorations and are addressed in this geotechnical computation package.

included in Drill Tech
Drilling & Shoring
calculations package.

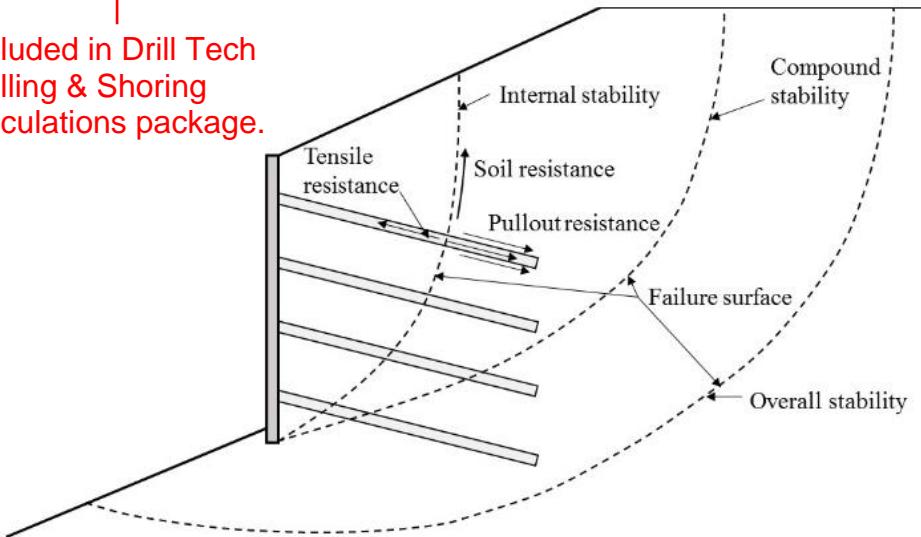


Figure 2 – Failure modes in soil nail walls from Figure C11.12.2-1 of AASHTO LRFD 2020.

Performance Requirements

Tables 3 and 4 show load and resistance factors for global stability analyses of temporary soil nail walls. By using EV=1.0, the 0.75 resistance factor equates to an ASD safety factor of 1.3 for the global and compound stability analysis.

Table 3 – Load factors for Permanent Loads from AASHTO (2020) Table 3.4.1-2.

Case		Load Factor
EV	Vertical Earth Pressure – Internal and compound stability for soil failure in soil nail walls	1.00

Table 4 – Resistance Factors for Soil Nail Walls from AASHTO (2020) Table 11.5.7-1.

Case	Resistance Factor	Factor of Safety
Overall and Compound Stability, soil failure	0.75	1.3

Global Stability

Global stability was analyzed for the critical condition, i.e. the construction stage where the TSNW has been installed and excavation to working grade for wall construction is complete. The analyses consider a section taken at the location of the maximum wall and foreslope height, which occurs at Wall Sta. 0+75 (Section A-A' in the RFU RW 07.15R Geotechnical Report).



The stability analyses indicate a safety factor of 1.40, satisfying the global stability performance requirement. Appendix A includes the global stability runs with the full output file for ease of checking and, if necessary, future duplication.

Soil/Grout Bond Strength

Chapter 15 Section 15-1 of the WSDOT Geotechnical Design Manual refers designers out to the Federal Highway Administration Geotechnical Engineering Circular No. 7, Soil Nail Walls for the design of soil nail walls. FHWA GEC No. 7 offers this guidance for selecting soil nail bond strengths:

"For preliminary design, the nominal bond strength of a soil nail can be estimated from published literature, correlations with parameters obtained from field tests, and soil nail load tests. Engineers may also estimate the bond strength based on local experience and construction techniques. The bond strength is not measured in the laboratory because the key aspects affecting the bond strength cannot be easily reproduced. Final design requires verification of the bond strengths with load tests (see Chapter 9)."

Typical ranges of the bond strength are included in Table 4.4 for gravity grouted soil nails. The bond strengths in Table 4.4 are provided for guidance. It is important that the design engineer estimates bond strengths based on soil descriptions and other factors, such as the soil shear strength and overburden, as described below. It is important that the bond strengths from Table 4.4 or any other source to be used in design must be confirmed in the field by soil nail load testing." Reference Appendix C for actual verification test results.

Four verification nails at the RW 07.15R TSNW site failed to achieve the initially selected 15 lb/in² soil/grout bond strength. Table 5 summarizes the test results.

Table 5 - Verification Test Results

Nail No.	Diameter (in)	Length (ft)	Failure Load		Test Date
			Force (kips)	Stress (lb/in ²)	
VN1	6	10	25.5	11.3	11 Oct 2021
VN2	6	10	23.0	10.1	11 Oct 2021
VN2.1	8	10	25.5	8.5	15 Oct 2021
VN2.2	8	10	24.0	8.0	15 Oct 2021

The verification nails achieved between 53% and 75% of the initially anticipated design value. Considering these data, and following the guidance in GEC 7, the soil nails have been reportioned for a 7.5 lb/in² ultimate bond strength.



Existing Structures

Soil nails will be installed close to the existing bridge abutment and some load will be transferred through the soil nails to the abutment. The stability of the abutment was evaluated frictional resistance between the soil and the abutment is about 4 times greater than the load transferred through the soil nails. For more details about the abutment loading analyses, see the 16 July 2021 May Creek Bridge Lateral Stability memorandum (attached in Appendix B).

Summary

Check this appendix reference, looks like it's actually
in Appendix C with the test results.

1. The planned RW 07.15R TSNW retains loose to medium dense compacted embankment fill that is more than 13 feet above the design groundwater elevation.
2. The nail arrangement is typical, but the verification tests revealed low soil/grout bond strength, so the nails are long relative to typical temporary soil nail walls in granular fill soils. The accompanying design computations provide additional detail about steel and concrete stresses and other internal stability design considerations.
3. At the critical construction stage, with the site excavated to working grade, but the timber pile ground improvement elements not yet in place, the wall-and-slope configuration has adequate safety against global instability.
4. The soil nail wall should be designed with the 7.5 lb/in^2 ultimate bond strength calculated from the verification tests.



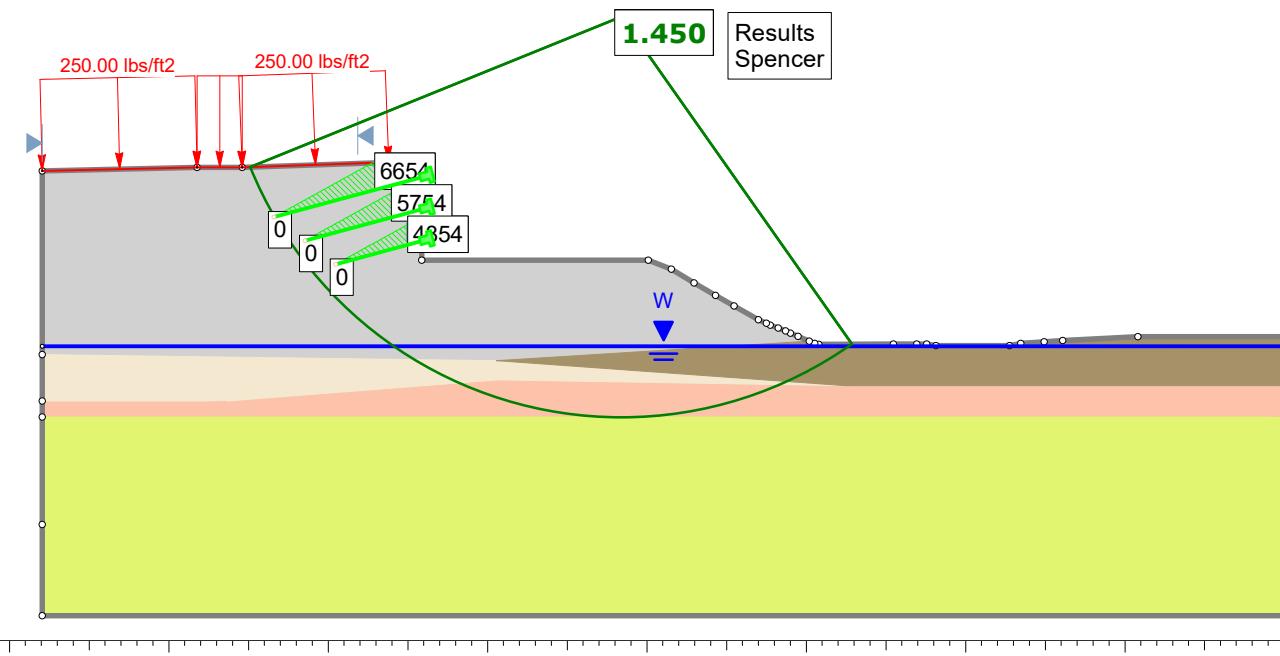
Appendix A – Global Stability Analysis



Pullout
 Stripping

Material Name	Color	Unit Weight (lbs/ft ³)	Strength Type	Cohesion (psf)	Phi (deg)	Cohesion Type	Water Surface
ESU 1A	Grey	115	Mohr-Coulomb	0	34		Water Surface
ESU 2A-1	Red	90	Undrained	370		Constant	Water Surface
ESU 2B	Light Brown	110	Mohr-Coulomb	0	29		Water Surface
ESU 2C-1	Brown	110	Undrained	800		Constant	Water Surface
ESU 4A	Yellow	135	Mohr-Coulomb	0	40		Water Surface

Support Name	Color	Type	Force Application	Out-Of-Plane Spacing (ft)	Tensile Capacity (lbs)	Plate Capacity (lbs)	Bond Strength (lbs/ft)	Force Orientation
Soil Nails	Green	Soil Nail	Active (Method A)	5	45000	23340	1800	Parallel to Reinforcement



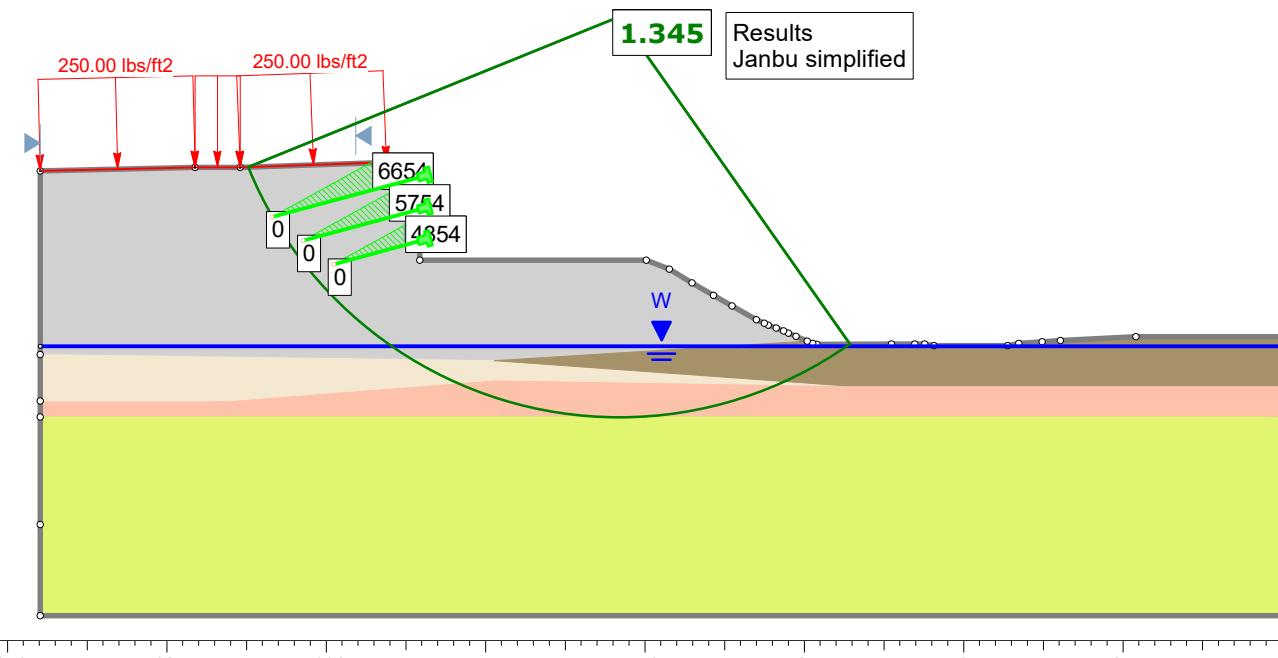
Project		RW 07.15R Temporary Soil Nail Wall	
Group	Group 1	Scenario	Master Scenario
Drawn By	Mike Little	Company	Atlas Geotechnical
Date	3/22/2021	File Name	07.15R TSNW Global Stability.slmd



Pullout
 Stripping

Material Name	Color	Unit Weight (lbs/ft ³)	Strength Type	Cohesion (psf)	Phi (deg)	Cohesion Type	Water Surface
ESU 1A	Grey	115	Mohr-Coulomb	0	34		Water Surface
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Support Name	Color	Type	Force Application	Out-Of-Plane Spacing (ft)	Tensile Capacity (lbs)	Plate Capacity (lbs)	Bond Strength (lbs/ft)	Force Orientation
Soil Nails	Green	Soil Nail	Active (Method A)	5	45000	23340	1800	Parallel to Reinforcement



Project

RW 07.15R Temporary Soil Nail Wall

Group	Group 1	Scenario	Master Scenario
Drawn By	Mike Little	Company	Atlas Geotechnical
Date	3/22/2021	File Name	07.15R TSNW Global Stability.slmd





07.15R TSNW Global Stability
RW 07.15R Temporary Soil Nail Wall
Atlas Geotechnical
Date Created: 3/22/2021
Software Version: 9.012

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Slide Analysis Information

07.15R TSNW Global Stability

Project Summary

File Name: 07.15R TSNW Global Stability.slmd
Slide Modeler Version: 9.012
Compute Time: 00h:00m:01.640s
Project Title: RW 07.15R Temporary Soil Nail Wall
Analysis: Global Stability
Author: Mike Little
Company: Atlas Geotechnical
Date Created: 3/22/2021

General Settings

Units of Measurement:

Imperial Units

Time Units:

days

Permeability Units:

feet/second

Data Output:

Standard

Failure Direction:

Left to Right

Analysis Options

Slices Type:	Vertical
Analysis Methods Used	
	Janbu simplified
	Spencer
Number of slices:	50
Tolerance:	0.005
Maximum number of iterations:	75
Check malpha < 0.2:	Yes
Create Interslice boundaries at intersections with water tables and piezos:	Yes
Initial trial value of FS:	1
Steffensen Iteration:	Yes

Groundwater Analysis

Groundwater Method:	Water Surfaces
Pore Fluid Unit Weight [lbs/ft ³]:	62.4
Use negative pore pressure cutoff:	Yes
Maximum negative pore pressure [psf]:	0
Advanced Groundwater Method:	None

Random Numbers

Pseudo-random Seed:

10116

Random Number Generation Method:

Park and Miller v.3

Surface Options

Surface Type:	Circular
Search Method:	Auto Refine Search
Divisions along slope:	20
Circles per division:	10
Number of iterations:	10
Divisions to use in next iteration:	50%
Composite Surfaces:	Disabled
Minimum Elevation:	Not Defined
Minimum Depth:	Not Defined
Minimum Area:	Not Defined
Minimum Weight:	Not Defined

Seismic Loading

Advanced seismic analysis:	No
Staged pseudostatic analysis:	No

Loading

1 Distributed Load present

Distributed Load 1

Distribution: Constant

Magnitude [psf]: 250

Orientation: Normal to boundary

Materials

ESU 1A

Color	
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	115
Cohesion [psf]	0
Friction Angle [deg]	34
Water Surface	Water Table
Hu Value	1

ESU 2A-1

Color	
Strength Type	Undrained
Unit Weight [lbs/ft3]	90
Cohesion [psf]	370
Cohesion Type	Constant
Water Surface	Water Table
Hu Value	1

ESU 2B

Color	
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	110
Cohesion [psf]	0
Friction Angle [deg]	29
Water Surface	Water Table
Hu Value	1

ESU 2C-1

Color	
Strength Type	Undrained
Unit Weight [lbs/ft3]	110
Cohesion [psf]	800
Cohesion Type	Constant
Water Surface	Water Table
Hu Value	1

ESU 4A

Color	
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	135
Cohesion [psf]	0
Friction Angle [deg]	40
Water Surface	Water Table
Hu Value	1

Support

Soil Nails

Color	
Support Type	Soil Nail
Force Application	Active
Force Orientation	Parallel to Reinforcement
Out-of-Plane Spacing [ft]	5
Tensile Capacity [lb]	45000
Plate Capacity [lb]	23340
Bond Strength [lb/ft]	1800
Material Dependent	No

Global Minimums

Method: janbu simplified

FS	1.344870
Center:	-53.995, 93.755
Radius:	62.878
Left Slip Surface Endpoint:	-112.261, 70.116
Right Slip Surface Endpoint:	-17.810, 42.332
Resisting Horizontal Force:	61599.7 lb
Driving Horizontal Force:	45803.4 lb
Active Horizontal Support Force:	-27.4017 lb
Maximum Single Support Force:	28.3684 lb
Total Support Force:	28.3684 lb
Total Slice Area:	1714.07 ft ²
Surface Horizontal Width:	94.4507 ft
Surface Average Height:	18.1478 ft

Method: spencer

FS	1.449680
Center:	-53.995, 93.755
Radius:	62.878
Left Slip Surface Endpoint:	-112.261, 70.116
Right Slip Surface Endpoint:	-17.810, 42.332
Resisting Moment:	4.64076e+06 lb-ft
Driving Moment:	3.20123e+06 lb-ft
Resisting Horizontal Force:	60568.3 lb
Driving Horizontal Force:	41780.4 lb
Active Support Moment:	-461.558 lb-ft
Active Horizontal Support Force:	-27.4017 lb
Maximum Single Support Force:	28.3684 lb
Total Support Force:	28.3684 lb
Total Slice Area:	1714.07 ft ²
Surface Horizontal Width:	94.4507 ft
Surface Average Height:	18.1478 ft

Global Minimum Support Data

Method: janbu simplified

Number of Supports: 3						
Soil Nails						
Support Type: Soil Nail						
Start (x, y)	Length (ft)	L Inside SS (ft)	L Outside SS (ft)	Li (ft)	Lo (ft)	Force (lb)
-85.342, 68.511	24	23.9212	0.078801	23.9212	0.078801	28.3684
-85.342, 63.511	19	Not Effective	Not Effective	Not Effective	Not Effective	0
-85.342, 58.511	14	Not Effective	Not Effective	Not Effective	Not Effective	0

Method: spencer

Number of Supports: 3						
Soil Nails						
Support Type: Soil Nail						
Start (x, y)	Length (ft)	L Inside SS (ft)	L Outside SS (ft)	Li (ft)	Lo (ft)	Force (lb)
-85.342, 68.511	24	23.9212	0.078801	23.9212	0.078801	28.3684
-85.342, 63.511	19	Not Effective	Not Effective	Not Effective	Not Effective	0
-85.342, 58.511	14	Not Effective	Not Effective	Not Effective	Not Effective	0

Valid and Invalid Surfaces

Method: janbu simplified

Number of Valid Surfaces:	8605
Number of Invalid Surfaces:	0

Method: spencer

Number of Valid Surfaces:	8537
Number of Invalid Surfaces:	68

Error Codes

Error Code -108 reported for 8 surfaces

Error Code -111 reported for 59 surfaces

Error Code -112 reported for 1 surface

Error Code Descriptions

The following errors were encountered during the computation:

-108 = Total driving moment or total driving force < 0.1. This is to limit the calculation of extremely high safety factors if the driving force is very small (0.1 is an arbitrary number).

-111 = Safety factor equation did not converge

-112 = The coefficient M-Alpha = $\cos(\alpha)(1+\tan(\alpha)\tan(\phi))/F < 0.2$ for the final iteration of the safety factor calculation. This screens out some slip surfaces which may not be valid in the context of the analysis, in particular, deep seated slip surfaces with many high negative base angle slices in the passive zone.

Slice Data

Global Minimum Query (janbu simplified) - Safety Factor: 1.34487

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [deg]	Base Material	Base Cohesion [psf]	Base Friction Angle [deg]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]	Base Vertical Stress [psf]	Effective Vertical Stress [psf]
1	1.87974	459.736	-65.8258	ESU 1A	0	34	117.07	157.444	233.422	0	233.422	494.229	494.229
2	1.87974	1307.33	-61.9146	ESU 1A	0	34	244.291	328.539	487.08	0	487.08	944.875	944.875
3	1.87974	2033.29	-58.4578	ESU 1A	0	34	368.423	495.481	734.581	0	734.581	1334.8	1334.8
4	1.87974	2672.1	-55.3152	ESU 1A	0	34	485.8	653.338	968.613	0	968.613	1670.6	1670.6
5	1.87974	3243.79	-52.4061	ESU 1A	0	34	599.706	806.526	1195.72	0	1195.72	1974.63	1974.63
6	1.87974	3761.29	-49.6785	ESU 1A	0	34	709.261	953.864	1414.16	0	1414.16	2249.86	2249.86
7	1.87974	4233.52	-47.0967	ESU 1A	0	34	814.703	1095.67	1624.4	0	1624.4	2501.02	2501.02
8	1.87974	4666.96	-44.6349	ESU 1A	0	34	916.267	1232.26	1826.9	0	1826.9	2731.57	2731.57
9	1.87974	5066.49	-42.2738	ESU 1A	0	34	1014.17	1363.93	2022.11	0	2022.11	2944.09	2944.09
10	1.87974	5435.89	-39.9982	ESU 1A	0	34	1108.62	1490.95	2210.42	0	2210.42	3140.6	3140.6
11	1.87974	5778.16	-37.7963	ESU 1A	0	34	1199.77	1613.54	2392.17	0	2392.17	3322.68	3322.68
12	1.87974	6095.73	-35.6583	ESU 1A	0	34	1246.72	1676.67	2485.77	0	2485.77	3380.25	3380.25
13	1.58992	5387.35	-33.7331	ESU 1A	0	34	1260.22	1694.83	2545.81	33.1228	2512.69	3387.32	3354.2
14	1.58992	5585.23	-32.0078	ESU 1A	0	34	1303.81	1753.46	2696.86	97.2533	2599.61	3511.82	3414.57
15	1.76814	5371.39	-30.2211	ESU 2B	0	29	956.137	1285.88	2480.18	160.394	2319.78	3037.14	2876.74
16	1.76814	3458.72	-28.3732	ESU 2B	0	29	584.361	785.889	1640.1	222.324	1417.78	1955.71	1733.39
17	1.76814	3637.73	-26.5569	ESU 2B	0	29	607.403	816.878	1753.38	279.692	1473.69	2056.97	1777.28
18	1.76814	3803.21	-24.7691	ESU 2B	0	29	629.537	846.645	1860.11	332.719	1527.39	2150.58	1817.86
19	2.0025	4470.49	-22.8914	ESU 2A-1	370	0	275.12	370	2116.13	384.554	1731.58	2232.3	1847.74
20	2.0025	4609.71	-20.9242	ESU 2A-1	370	0	275.12	370	2196.65	434.823	1761.82	2301.84	1867.01
21	2.0025	4734.81	-18.9825	ESU 2A-1	370	0	275.12	370	2269.69	480.203	1789.48	2364.32	1884.12
22	2.0025	4848.85	-17.0632	ESU 2A-1	370	0	275.12	370	2336.84	520.871	1815.97	2421.28	1900.41
23	2.0025	4953.18	-15.1635	ESU 2A-1	370	0	275.12	370	2398.84	556.98	1841.86	2473.4	1916.42
24	2.0025	5044.74	-13.2807	ESU 2A-1	370	0	275.12	370	2454.19	588.659	1865.54	2519.13	1930.47
25	2.0025	5123.81	-11.4124	ESU 2A-1	370	0	275.12	370	2503.1	616.018	1887.08	2558.63	1942.62
26	2.0025	5190.68	-9.55634	ESU 2A-1	370	0	275.12	370	2545.72	639.148	1906.57	2592.04	1952.89
27	2.0025	5245.55	-7.71037	ESU 2A-1	370	0	275.12	370	2582.2	658.125	1924.07	2619.45	1961.32
28	2.0025	5288.6	-5.87243	ESU 2A-1	370	0	275.12	370	2612.66	673.01	1939.65	2640.96	1967.95
29	2.0025	5319.96	-4.04055	ESU 2A-1	370	0	275.12	370	2637.2	683.85	1953.35	2656.63	1972.78
30	2.0025	5339.74	-2.21279	ESU 2A-1	370	0	275.12	370	2655.89	690.677	1965.21	2666.52	1975.84
31	2.85243	7616.14	0	ESU 2A-1	370	0	275.12	370	2670.05	693.091	1976.96	2670.05	1976.96
32	1.95551	5214.8	2.19135	ESU 2A-1	370	0	275.12	370	2677.26	690.757	1986.5	2666.73	1975.97
33	1.95551	5167.79	3.97613	ESU 2A-1	370	0	275.12	370	2661.83	684.181	1977.65	2642.7	1958.52
34	1.95551	4983.18	5.76479	ESU 2A-1	370	0	275.12	370	2576.09	673.781	1902.3	2548.31	1874.53
35	1.95551	4746.16	7.5591	ESU 2A-1	370	0	275.12	370	2463.62	659.525	1804.1	2427.12	1767.59
36	1.95551	4429.77	9.36092	ESU 2A-1	370	0	275.12	370	2310.69	641.371	1669.32	2265.33	1623.96
37	1.95551	4103.79	11.1721	ESU 2A-1	370	0	275.12	370	2152.98	619.263	1533.72	2098.65	1479.38
38	1.95551	3773.67	12.9947	ESU 2A-1	370	0	275.12	370	1993.34	593.133	1400.2	1929.85	1336.71
39	1.95551	3437.19	14.8308	ESU 2A-1	370	0	275.12	370	1830.64	562.898	1267.74	1757.79	1194.89
40	1.95551	3092.42	16.6827	ESU 2A-1	370	0	275.12	370	1663.95	528.459	1135.49	1581.5	1053.04
41	1.95551	2738.32	18.5527	ESU 2A-1	370	0	275.12	370	1492.77	489.698	1003.07	1400.43	910.734
42	1.95551	2386.38	20.4434	ESU 2A-1	370	0	275.12	370	1323.03	446.478	876.547	1220.47	773.994
43	1.95551	2055.84	22.3577	ESU 2A-1	370	0	275.12	370	1164.61	398.641	765.973	1051.46	652.814
44	1.09465	1005.76	23.8665	ESU 2B	0	29	282.559	380.005	1043.98	358.436	685.548	918.969	560.533
45	1.94433	1489.77	25.3925	ESU 2C-1	800	0	594.853	800	1048.95	314.53	734.422	766.591	452.061
46	1.94433	1102.81	27.3707	ESU 2C-1	800	0	594.853	800	875.56	254.33	621.23	567.604	313.274
47	1.94433	730.45	29.385	ESU 2C-1	800	0	594.853	800	711.105	188.763	522.342	376.128	187.365
48	1.94433	468.656	31.44	ESU 2C-1	800	0	594.853	800	605.191	117.515	487.676	241.52	124.005
49	1.94433	206.661	33.5413	ESU 2C-1	800	0	594.853	800	501.153	40.2135	460.94	106.812	66.5984
50	0.476601	8.61644	34.8688	ESU 2C-1	800	0	594.853	800	433.123	0	433.123	18.6281	18.6281

Global Minimum Query (spencer) - Safety Factor: 1.44968

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [deg]	Base Material	Base Cohesion [psf]	Base Friction Angle [deg]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]	Base Vertical Stress [psf]	Effective Vertical Stress [psf]
1	1.87974	459.736	-65.8258	ESU 1A	0	34	96.82	140.358	208.09	0	208.09	423.784	423.784
2	1.87974	1307.33	-61.9146	ESU 1A	0	34	205.272	297.578	441.177	0	441.177	825.851	825.851
3	1.87974	2033.29	-58.4578	ESU 1A	0	34	314.105	455.352	675.086	0	675.086	1186.81	1186.81
4	1.87974	2672.1	-55.3152	ESU 1A	0	34	417.753	605.608	897.852	0	897.852	1501.51	1501.51
5	1.87974	3243.79	-52.4061	ESU 1A	0	34	520.589	754.687	1118.87	0	1118.87	1795.02	1795.02
6	1.87974	3761.29	-49.6785	ESU 1A	0	34	620.971	900.209	1334.62	0	1334.62	2066.28	2066.28
7	1.87974	4233.52	-47.0967	ESU 1A	0	34	718.917	1042.2	1545.13	0	1545.13	2318.68	2318.68
8	1.87974	4666.96	-44.6349	ESU 1A	0	34	814.497	1180.76	1750.54	0	1750.54	2554.72	2554.72
9	1.87974	5066.49	-42.2738	ESU 1A	0	34	907.773	1315.98	1951.03	0	1951.03	2776.28	2776.28
10	1.87974	5435.89	-39.9982	ESU 1A	0	34	998.848	1448.01	2146.77	0	2146.77	2984.85	2984.85
11	1.87974	5778.16	-37.7963	ESU 1A	0	34	1087.8	1576.96	2337.94	0	2337.94	3181.61	3181.61
12	1.87974	6095.73	-35.6583	ESU 1A	0	34	1137.47	1648.97	2444.7	0	2444.7	3260.8	3260.8
13	1.58992	5387.35	-33.7331	ESU 1A	0	34	1154.9	1674.23	2515.26	33.1228	2482.14	3286.45	3253.33
14	1.58992	5585.23	-32.0078	ESU 1A	0	34	1198.07	1736.82	2672.2	97.2533	2574.95	3421.06	3323.81
15	1.76814	5371.39	-30.2211	ESU 2B	0	29	866.798	1256.58	2427.32	160.394	2266.93	2932.24	2771.84
16	1.76814	3458.72	-28.3732	ESU 2B	0	29	528.813	766.609	1605.32	222.324	1383	1890.93	1668.61
17	1.76814	3637.73	-26.5569	ESU 2B	0	29	551.531	799.543	1722.11	279.692	1442.41	1997.77	1718.08
18	1.76814	3803.21	-24.7691	ESU 2B	0	29	573.924	832.006	1833.7	332.719	1500.98	2098.51	1765.79
19	2.0025	4470.49	-22.8914	ESU 2A-1	370	0	255.229	370	2011.53	384.554	1626.98	2119.3	1734.74
20	2.0025	4609.71	-20.9242	ESU 2A-1	370	0	255.229	370	2099.97	434.823	1665.15	2197.56	1762.73
21	2.0025	4734.81	-18.9825	ESU 2A-1	370	0	255.229	370	2182.12	480.203	1701.92	2269.92	1789.71
22	2.0025	4848.85	-17.0632	ESU 2A-1	370	0	255.229	370	2259.36	520.871	1738.49	2337.7	1816.83
23	2.0025	4953.18	-15.1635	ESU 2A-1	370	0	255.229	370	2332.31	556.98	1775.33	2401.48	1844.5
24	2.0025	5044.74	-13.2807	ESU 2A-1	370	0	255.229	370	2399.48	588.659	1810.82	2459.73	1871.07
25	2.0025	5123.81	-11.4124	ESU 2A-1	370	0	255.229	370	2460.97	616.018	1844.95	2512.49	1896.47
26	2.0025	5190.68	-9.55634	ESU 2A-1	370	0	255.229	370	2516.87	639.148	1877.72	2559.84	1920.69
27	2.0025	5245.55	-7.71037	ESU 2A-1	370	0	255.229	370	2567.24	658.125	1909.11	2601.79	1943.67
28	2.0025	5288.6	-5.87243	ESU 2A-1	370	0	255.229	370	2612.14	673.01	1939.13	2638.39	1965.38
29	2.0025	5319.96	-4.04055	ESU 2A-1	370	0	255.229	370	2651.59	683.85	1967.74	2669.62	1985.77
30	2.0025	5339.74	-2.21279	ESU 2A-1	370	0	255.229	370	2685.63	690.677	1994.95	2695.49	2004.81
31	2.85243	7616.14	0	ESU 2A-1	370	0	255.229	370	2718.87	693.091	2025.77	2718.87	2025.77
32	1.95551	5214.8	2.19135	ESU 2A-1	370	0	255.229	370	2745.4	690.757	2054.64	2735.63	2044.88
33	1.95551	5167.79	3.97613	ESU 2A-1	370	0	255.229	370	2745.74	684.181	2061.56	2728	2043.82
34	1.95551	4983.18	5.76479	ESU 2A-1	370	0	255.229	370	2674.5	673.781	2000.71	2648.73	1974.95
35	1.95551	4746.16	7.5591	ESU 2A-1	370	0	255.229	370	2575.08	659.525	1915.56	2541.21	1881.69
36	1.95551	4429.77	9.36092	ESU 2A-1	370	0	255.229	370	2432.81	641.371	1791.44	2390.74	1749.37
37	1.95551	4103.79	11.1721	ESU 2A-1	370	0	255.229	370	2283.98	619.263	1664.72	2233.57	1614.31
38	1.95551	3773.67	12.9947	ESU 2A-1	370	0	255.229	370	2131.4	593.133	1538.27	2072.51	1479.37
39	1.95551	3437.19	14.8308	ESU 2A-1	370	0	255.229	370	1973.85	562.898	1410.95	1906.27	1343.37
40	1.95551	3092.42	16.6827	ESU 2A-1	370	0	255.229	370	1810.17	528.459	1281.71	1733.68	1205.22
41	1.95551	2738.32	18.5527	ESU 2A-1	370	0	255.229	370	1639.69	489.698	1149.99	1554.03	1064.33
42	1.95551	2386.38	20.4434	ESU 2A-1	370	0	255.229	370	1468.56	446.478	1022.08	1373.42	926.946
43	1.95551	2055.84	22.3577	ESU 2A-1	370	0	255.229	370	1307.45	398.641	908.808	1202.47	803.831
44	1.09465	1005.76	23.8665	ESU 2B	0	29	333.336	483.23	1230.21	358.436	871.772	1082.73	724.291
45	1.94433	1489.77	25.3925	ESU 2C-1	800	0	551.846	800	1246.44	314.53	931.909	984.492	669.962
46	1.94433	1102.81	27.3707	ESU 2C-1	800	0	551.846	800	1063.22	254.33	808.891	777.529	523.199
47	1.94433	730.45	29.385	ESU 2C-1	800	0	551.846	800	886.998	188.763	698.235	576.239	387.476
48	1.94433	468.656	31.44	ESU 2C-1	800	0	551.846	800	773.834	117.515	656.319	436.456	318.941
49	1.94433	206.661	33.5413	ESU 2C-1	800	0	551.846	800	660.763	40.2135	620.549	294.932	254.718
50	0.476601	8.61644	34.8688	ESU 2C-1	800	0	551.846	800	587.855	0	587.855	203.328	203.328

Interslice Data

Global Minimum Query (janbu simplified) - Safety Factor: 1.34487

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [deg]
1	-112.261	70.1162	0	0	0
2	-110.381	65.9286	773.587	0	0
3	-108.501	62.406	2046.01	0	0
4	-106.621	59.3436	3591.17	0	0
5	-104.742	56.6274	5324.22	0	0
6	-102.862	54.1859	7131.16	0	0
7	-100.982	51.9711	8944.73	0	0
8	-99.1023	49.9485	10713.2	0	0
9	-97.2226	48.0926	12395.7	0	0
10	-95.3429	46.3837	13958.7	0	0
11	-93.4631	44.8065	15374.7	0	0
12	-91.5834	43.3487	16620.4	0	0
13	-89.7037	42	17635.4	0	0
14	-88.1137	40.9383	18331.9	0	0
15	-86.5238	39.9445	18936.3	0	0
16	-84.7557	38.9146	19798	0	0
17	-82.9875	37.9596	20329.6	0	0
18	-81.2194	37.0759	20803.8	0	0
19	-79.4513	36.26	21206.7	0	0
20	-77.4488	35.4145	22444.3	0	0
21	-75.4462	34.6488	23574.5	0	0
22	-73.4437	33.96	24586.3	0	0
23	-71.4412	33.3454	25471	0	0
24	-69.4387	32.8027	26221.2	0	0
25	-67.4362	32.33	26829.5	0	0
26	-65.4337	31.9258	27289.7	0	0
27	-63.4312	31.5887	27596.2	0	0
28	-61.4287	31.3175	27744.7	0	0
29	-59.4262	31.1116	27731.1	0	0
30	-57.4237	30.9701	27552.5	0	0
31	-55.4212	30.8927	27206.3	0	0
32	-52.5688	30.8927	26420.5	0	0
33	-50.6133	30.9676	25681.5	0	0
34	-48.6578	31.1035	24781	0	0
35	-46.7023	31.3009	23733.7	0	0
36	-44.7468	31.5604	22555.7	0	0
37	-42.7913	31.8828	21272.1	0	0
38	-40.8357	32.269	19901.8	0	0
39	-38.8802	32.7203	18463.6	0	0
40	-36.9247	33.2381	16977	0	0
41	-34.9692	33.8241	15463.1	0	0
42	-33.0137	34.4804	13944.7	0	0
43	-31.0582	35.2093	12441.6	0	0
44	-29.1027	36.0137	10966.2	0	0
45	-28.008	36.498	10150.8	0	0
46	-26.0637	37.4209	8024.62	0	0
47	-24.1194	38.4275	5985.17	0	0
48	-22.1751	39.5224	4048.46	0	0
49	-20.2307	40.7111	2170.95	0	0
50	-18.2864	42	366.875	0	0
51	-17.8098	42.3321	0	0	0

Global Minimum Query (spencer) - Safety Factor: 1.44968

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [deg]
1	-112.261	70.1162	0	0	0
2	-110.381	65.9286	705.445	134.66	10.807
3	-108.501	62.406	1889.24	360.63	10.807
4	-106.621	59.3436	3353.87	640.208	10.807
5	-104.742	56.6274	5022.01	958.634	10.807
6	-102.862	54.1859	6789.27	1295.98	10.807
7	-100.982	51.9711	8591.71	1640.04	10.807
8	-99.1023	49.9485	10378.8	1981.18	10.807
9	-97.2226	48.0926	12109.6	2311.56	10.807
10	-95.3429	46.3837	13749.8	2624.65	10.807
11	-93.4631	44.8065	15270.2	2914.87	10.807
12	-91.5834	43.3487	16645.6	3177.41	10.8069
13	-89.7037	42	17808.7	3399.43	10.8069
14	-88.1137	40.9383	18638.6	3557.86	10.807
15	-86.5238	39.9445	19385	3700.33	10.807
16	-84.7557	38.9146	20348.9	3884.32	10.807
17	-82.9875	37.9596	20944.7	3998.06	10.807
18	-81.2194	37.0759	21489.2	4102	10.807
19	-79.4513	36.26	21968.1	4193.41	10.807
20	-77.4488	35.4145	23156.6	4420.28	10.807
21	-75.4462	34.6488	24252.2	4629.41	10.807
22	-73.4437	33.96	25243	4818.55	10.807
23	-71.4412	33.3454	26119.4	4985.85	10.807
24	-69.4387	32.8027	26872.9	5129.67	10.807
25	-67.4362	32.33	27494.7	5248.38	10.807
26	-65.4337	31.9258	27977.3	5340.48	10.807
27	-63.4312	31.5887	28313.5	5404.66	10.807
28	-61.4287	31.3175	28497.2	5439.74	10.807
29	-59.4262	31.1116	28523	5444.65	10.807
30	-57.4237	30.9701	28385.8	5418.46	10.807
31	-55.4212	30.8927	28081.3	5360.34	10.807
32	-52.5688	30.8927	27351.6	5221.05	10.807
33	-50.6133	30.9676	26645.9	5086.34	10.807
34	-48.6578	31.1035	25772.4	4919.61	10.807
35	-46.7023	31.3009	24744.2	4723.33	10.807
36	-44.7468	31.5604	23575.7	4500.28	10.807
37	-42.7913	31.8828	22291.2	4255.09	10.807
38	-40.8357	32.269	20908.8	3991.21	10.807
39	-38.8802	32.7203	19446.7	3712.12	10.807
40	-36.9247	33.2381	17924.4	3421.53	10.807
41	-34.9692	33.8241	16363.3	3123.54	10.807
42	-33.0137	34.4804	14787	2822.63	10.8069
43	-31.0582	35.2093	13216.2	2522.8	10.807
44	-29.1027	36.0137	11664.4	2226.57	10.807
45	-28.008	36.498	10702.8	2043.02	10.807
46	-26.0637	37.4209	8477.01	1618.15	10.807
47	-24.1194	38.4275	6331.35	1208.57	10.807
48	-22.1751	39.5224	4284.73	817.896	10.807
49	-20.2307	40.7111	2289.43	437.022	10.807
50	-18.2864	42	362.307	69.1595	10.807
51	-17.8098	42.3321	0	0	0

Entity Information

◆ Group 1

Shared Entities

Type	Coordinates (x,y)
External Boundary	-144.921, -0.246 50.197, -0.246 50.197, 4.164 50.197, 30.8927 50.197, 35.849 50.197, 43.499 27.013, 43.499 15.205, 42.939 12.323, 42.694 8.632, 42.449 6.908, 42.131 -4.633, 42.131 -6.104, 42.378 -7.661, 42.378 -11.354, 42.378 -23.027, 42.295 -23.663, 42.475 -24.5235, 42.8318 -26.28, 43.56 -27.492, 44.052 -28.266, 44.411 -29.413, 44.854 -30.653, 45.349 -31.26, 45.651 -32.501, 46.189 -36.353, 48.332 -39.26, 49.976 -42.621, 51.937 -46.18, 54.112 -49.789, 55.511 -85.342, 55.511 -85.342, 71.006 -86.849, 71.006 -113.495, 70.073 -120.618, 70.073 -144.921, 69.541 -144.921, 40.6963 -144.921, 33.438 -144.921, 30.8927 -144.921, 14.0512
Material Boundary	-144.921, 30.8927 50.197, 30.8927
Material Boundary	-144.921, 33.438 -115.813, 33.438 -73.344, 36.734 -18.99, 35.849 50.197, 35.849
Material Boundary	-144.921, 40.6963 -73.587, 39.778 -18.99, 35.849
Material Boundary	-73.587, 39.778 -24.5235, 42.8318

Scenario-based Entities

Type	Coordinates (x,y)	Master Scenario
Water Table	-144.921, 42 50.197, 42	Assigned to:  ESU 1A ESU 2A-1 ESU 2B ESU 2C-1 ESU 4A
Distributed Load	-90.5414, 70.8767 -113.495, 70.073 -120.618, 70.073 -144.921, 69.541	Constant DistributionOrientation: Normal to boundaryMagnitude: 250 lbs/ft ² Creates Excess Pore Pressure: No

DTDS

RW 07.15R TSNW

Appendix B – May Creek Bridge Lateral Stability Memo



9 December 2021

DTDS

RW 07.15R TSNW

Appendix C – Verification Test Reports



9 December 2021

Memorandum



Project: I-405 R2B

Subject: RW 07.15R TSNW

Date: 16 July 2021

Soil Nail Wall Influence on May Creek Bridge Abutment

RW 07.15R TSNW is a temporary soil nail wall 66 ft long and 15 feet high that will shore the east side of the embankment on the north end of the May Creek Bridge. Six of the 32 nails are close to the north bridge abutment, arranged in a column of three on each side.

Comment No. 4 of WSDOT's review requests the designer to ensure that soil nail forces do not affect the May Creek Bridge abutment.

The concerning failure mode appears to be these six soil nails dragging the bridge laterally out of its embankment. Though such instability seems implausible, WSDOT cites RFP 2.13.4.1 requiring analysis of all existing structural elements whose load carrying capacities are altered by the work. Excavating a vertical face alongside the bridge and supporting the cut with soil nails does, in fact, change the stress state in the embankment and, by extension, the bridge abutment.

Section 7.2.1 of Drill Tech Drilling & Shoring's (DTDS's) 21 June 2021 computations report 12.12 kips maximum nail head force inclined 15° above horizontal. These nail forces resolve into the ground as shear along the soil/grout interface behind the hypothetical failure wedge.

Assuming that half of each nail's shear force accrues to the bridge abutment (the other half resolves into embankment soils away from the bridge), and that the upward component is inconsequential relative to the bridge dead weight, the six nearby nails exert a combined 35-kip lateral force on the bridge abutment.

The 40-ft wide bridge abutment is embedded about 15 feet in compacted fill. Assuming K_0 lateral earth pressures, a 32° soil/concrete interface, and 5 feet of width that might be inside the active failure plane, the stabilizing soil friction on the north abutment face is 138 kips. This stabilizing force is about four times larger than the soil nail force, indicating that the nail forces are not large enough to adversely impact abutment stability.

More stabilizing forces that could be quantified if simple friction were not sufficient include:

1. Friction on the entire inboard bridge abutment face,
2. Friction along the abutment base,
3. The bridge foundation lateral capacity. Considering that the foundation was designed to resist transverse seismic loads, these stabilizing forces might be quite large.

On this basis we conclude that the stress state changes related to TSNW construction are not large enough to impact the existing bridge.





2200 Wymore Way, Antioch, CA 94509
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Project: I-405 Renton to Bellevue Widening & Express Toll Lanes

Location: Renton to Bellevue, WA

Foreman: Scott Brown

Date: 10/11/2021

Sheet

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Soil Nail Verification Test

Soil Nail No: VN-1
Embedment Length (ft.) 10
Retaining Wall No: RW 7.15R

TEST LOAD		
Lb (ft):	10	
Qd (kips/ft):	1.7	
DTL (kips):	17	

START 8:11

*CANT REACH 2800 psi NAIL JUST PULLS OUT.

Ram Information

Ram No.: 50-6-9
Gauge No.: 50-6-9A
Calibr. Date 09/28/21

Testing Schedule

Load	Load	50-6-9A	Elongation (Inches)											
			1 Min.	2 Min.	3 Min.	4 Min.	5 Min.	6 Min.	10 min.	20 min.	30 Min.	40 Min.	50 Min.	60 Min.
AL (0.10 DTL)	1.70	200 150	.000											
0.25 DTL	4.25	350	.027	Reading at beginning of 10-minute hold										
0.50 DTL	8.50	750	.095	Reading at beginning of 10-minute hold										
0.75 DTL	12.75	1100	.180	Reading at beginning of 10-minute hold										
1.00 DTL	17.00	1550	.299	Reading at beginning of 10-minute hold										
1.25 DTL	21.25	1950	.452	Reading at beginning of 10-minute hold	1.162									
1.50 DTL (Creep*)	25.50	2400	1.155	1.159	1.162		1.162	1.163	1.164	1.167	1.169	1.210	1.211	1.213
1.75 DTL	29.75	2800	5	Reading at beginning of 10-minute hold								1.201		
2.00 DTL (MTL)	34.00	3250		Reading at beginning of 10-minute hold										
AL (0.10 DTL)	1.70	150	1.480											

AL = Alignment Load, DTL = Design Test Load

*Hold the load to within 2 percent and measure and record soil nail movement at 1, 2, 3, 4, 5, 6, 10, 20, 30, 40, 50, and 60 minutes

Verification Test Acceptance Criteria:

A verification tested nail with a 60-minute load hold at 1.50TL is acceptable if:

- 1) Creep rate does not exceed 0.08 inch from 1-min to 60-minutes.
- 2) Total movement measured at the Maximum Test Load (MTL=2.00 DTL) exceeds 80 percent of theoretical elastic elongation of the non-bonded length.

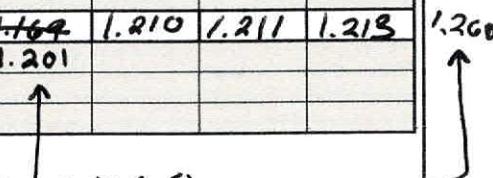
Elongation Calculations

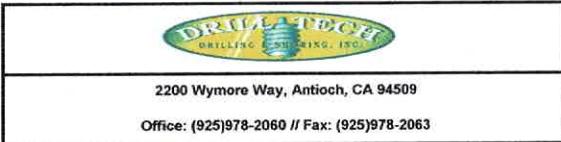
$$\begin{aligned}
 MTL &= 34.00 \text{ kips} & Lu (\text{Unbonded Length}) &= 7 \text{ ft.} \\
 E &= 29000 \text{ ksi} & A (\text{X-Section Area}) &= 0.600 \text{ sq. in} \quad \#7 \text{ Bar} \\
 \text{Theoretical Elongation} &= 0.1559 \text{ inches} \\
 80\% \text{ Theoretical Elongation} &= 0.1247 \text{ inches} \\
 \text{Actual Elongation} &= \text{inches}
 \end{aligned}$$

Ram Load	Load Cell Reading
1.70	2,800
4.25	4,350
8.50	8,000
12.75	11,800
17.00	15,000
21.25	19,200
25.50	24,000
29.75	
34.00	
1.70	

Total Creep Movement
From 1- to 60-minutes: _____ inches

BUMPED BACK TO
2400 PSI





Project:	I-405 Renton to Bellevue Widening & Express Toll Lanes
Location:	Renton to Bellevue, WA
Foreman:	Scott Brown
Date:	10-11-2021 Job No. 20018

Sheet
1

START 11:31

Soil Nail Verification Test (NORTH)

Soil Nail No:

V2

Embedment Length (ft.)

10

Retaining Wall No:

RW 7.15R

TEST LOAD		
Lb (ft):	10	
Qd (kips/ft):	1.7	
DTL (kips):	17	

* HAD SMALL CAVE-IN ABOUT 4' INTO HOLE,
BROKE PAST IT WITH T-POST. MEASURED 3' OF
WATER ON TOP OF GROUT. 10' BOND

* CANT REACH 2400 psi, SETTLES BACK TO 2200 psi

Ram Information
Ram No.: 50-6-9
Gauge No.: 50-6-9A
Calibr. Date 09/28/21

Testing Schedule

Load	Load	50-6-9A	Elongation (Inches)													
			1 Min.	2 Min.	3 Min.	4 Min.	5 Min.	6 Min.	10 min.	20 min.	30 Min.	40 Min.	50 Min.	60 Min.		
AL (0.10 DTL)	1.70	150	.000													
0.25 DTL	4.25	350	.029	Reading at beginning of 10-minute hold												
0.50 DTL	8.50	750	.045	Reading at beginning of 10-minute hold												
0.75 DTL	12.75	1100	.316	Reading at beginning of 10-minute hold												
1.00 DTL	17.00	1550	.574	Reading at beginning of 10-minute hold												
1.25 DTL	21.25	1950	1.028	Reading at beginning of 10-minute hold												
1.50 DTL (Creep*)	25.50	2250	2.123	Reading at beginning of 10-minute hold												
1.75 DTL	29.75	2800		Reading at beginning of 10-minute hold												
2.00 DTL (MTL)	34.00	3250		Reading at beginning of 10-minute hold												
AL (0.10 DTL)	1.70	150	-1.885	1.885												

AL = Alignment Load; DTL = Design Test Load

*Hold the load to within 2 percent and measure and record soil nail movement at 1, 2, 3, 4, 5, 6, 10, 20, 30, 40, 50, and 60 minutes

Verification Test Acceptance Criteria:

A verification tested nail with a 60-minute load hold at 1.50TL is acceptable if:

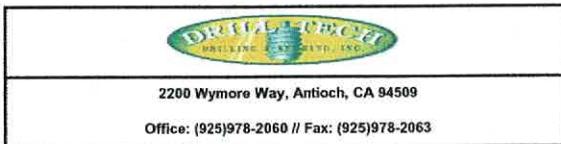
1) Creep rate does not exceed 0.08 inch from 1-min to 60-minutes.

2) Total movement measured at the Maximum Test Load (MTL=2.00 DTL) exceeds 80 percent of theoretical elastic elongation of the non-bonded length.

Elongation Calculations

$$\begin{aligned}
 MTL &= 34.00 \text{ kips} & Lu (\text{Unbonded Length}) &= 7 \text{ ft.} \\
 E &= 29000 \text{ ksi} & A (\text{X-Section Area}) &= 0.600 \text{ sq. in.} \quad \#7 \text{ Bar} \\
 \text{Theoretical Elongation} &= 0.1559 \text{ inches} \\
 80\% \text{ Theoretical Elongation} &= 0.1247 \text{ inches} \\
 \text{Actual Elongation} &= \text{inches}
 \end{aligned}$$

Load Cell	Reading	Total Creep Movement
Ram Load		From 1- to 60-minutes: _____ inches
1.70	2900	
4.25	4500	
8.50	?	
12.75	15700	
17.00	20,100	
21.25		
25.50		
29.75		
34.00		
1.70		



Project:	I-405 Renton to Bellevue Widening & Express Toll Lanes
Location:	Renton to Bellevue, WA
Foreman:	Scott Brown
Date:	10/16/21

Sheet

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Soil Nail Verification Test

Soil Nail No: VN2.1
 Embedment Length (ft): 10
 Retaining Wall No: RW 7.15R

TEST LOAD	
Lb (ft):	10
Qd (kips/ft):	1.7
DTL (kips):	17

8-inch Diameter Hole

HOLDING @ 2700 psi pulls out
TRYING TO GET TO 175% @ 2965 psi

Ram Information

Ram No.: 50-6-9
 Gauge No.: 50-6-9A
 Calibr. Date 09/28/21

Testing Schedule

Load	Load	50-6-9A	Elongation (Inches)											
			1 Min.	2 Min.	3 Min.	4 Min.	5 Min.	6 Min.	10 min.	20 min.	30 Min.	40 Min.	50 Min.	60 Min.
Level	(kips)	(psi)												
AL (0.10 DTL)	1.70	450 2 ¹⁴ .000												
0.25 DTL	4.25	950 2 ¹⁴ .010	Reading at beginning of 10-minute hold											
0.50 DTL	8.50	750 2 ¹³ .064	Reading at beginning of 10-minute hold											
0.75 DTL	12.75	1100 1 ¹¹ .156	Reading at beginning of 10-minute hold											
1.00 DTL	17.00	1550 1 ¹⁰ .294	Reading at beginning of 10-minute hold											
1.25 DTL	21.25	1950 2 ⁰⁸ .308	Reading at beginning of 10-minute hold											
1.50 DTL (Creep*)	25.50	2400 2 ⁰⁶ .148	1.151	1.151	1.151	1.151	1.151	1.151	1.152	1.152	1.152	1.170	1.171	1.172
1.75 DTL	29.75	2800 2 ⁰⁵ .224	Reading at beginning of 10-minute hold											
2.00 DTL (MTL)	34.00	3250 3 ¹³ .313	Reading at beginning of 10-minute hold											
AL (0.10 DTL)	1.70	750 2 ⁰⁰												

AL = Alignment Load; DTL = Design Test Load

*Hold the load to within 2 percent and measure and record soil nail movement at 1, 2, 3, 4, 5, 6, 10, 20, 30, 40, 50, and 60 minutes

Verification Test Acceptance Criteria:

A verification tested nail with a 60-minute load hold at 1.50TL is acceptable if:

1) Creep rate does not exceed 0.08 inch from 1-min to 60-minutes.

2) Total movement measured at the Maximum Test Load (MTL=2.00 DTL) exceeds 80 percent of theoretical elastic elongation of the non-bonded length.

Elongation Calculations

$$\begin{aligned}
 MTL &= 34.00 \text{ kips} & Lu (\text{Unbonded Length}) &= 7 \text{ ft.} \\
 E &= 29000 \text{ ksi} & A (\text{X-Section Area}) &= 0.600 \text{ sq. in.} \quad \#7 \text{ Bar} \\
 \text{Theoretical Elongation} &= 0.1559 \text{ inches} \\
 80\% \text{ Theoretical Elongation} &= 0.1247 \text{ inches} \\
 \text{Actual Elongation} &= \text{inches}
 \end{aligned}$$

Load Cell	Ram Load	Reading
	1.70	2800
	4.25	3500
	8.50	7700
	12.75	11600
	17.00	16500
	21.25	SKIPPED
	25.50	24400
	29.75	25200
	34.00	
	1.70	

Total Creep Movement
From 1- to 60-minutes: .024 inches



Project:	I-405 Renton to Bellevue Widening & Express Toll Lanes
Location:	Renton to Bellevue, WA
Foreman:	Scott Brown
Date:	10/16/21
Job No.	20018

Sheet
1

Soil Nail Verification Test

Soil Nail No: VN 2.3
Embedment Length (ft): 10
Retaining Wall No: RW 7.15R

TEST LOAD		
Lb (ft):	10	
Qd (kips/ft):	1.7	
DTL (kips):	17	

8-inch Diameter Hole

CANT HOLD 2400 PSI
SETTLES BACK TO 2200 PSI

Ram Information

Ram No.: 50-6-9
Gauge No.: 50-6-9A
Calibr. Date 09/28/21

Testing Schedule

Load	Load	50-6-9A	Elongation (Inches)											
			1 Min.	2 Min.	3 Min.	4 Min.	5 Min.	6 Min.	10 min.	20 min.	30 Min.	40 Min.	50 Min.	60 Min.
AL (0.10 DTL)	1.70	200 150	.000											
0.25 DTL	4.25	350	.018	Reading at beginning of 10-minute hold					.020					
0.50 DTL	8.50	750	.108	Reading at beginning of 10-minute hold					.108					
0.75 DTL	12.75	1100	.295	Reading at beginning of 10-minute hold					.305					
1.00 DTL	17.00	1550	.531	Reading at beginning of 10-minute hold					.559					
1.25 DTL	21.25	1950	.844	Reading at beginning of 10-minute hold					.888					
1.50 DTL (Creep*)	25.50	2400	1.609	1.609	1.648	1.648	1.649	1.649	1.651	1.866				
1.75 DTL	29.75	2800		Reading at beginning of 10-minute hold										
2.00 DTL (MTL)	34.00	3250		Reading at beginning of 10-minute hold										
AL (0.10 DTL)	1.70	150												

AL = Alignment Load; DTL = Design Test Load

*Hold the load to within 2 percent and measure and record soil nail movement at 1, 2, 3, 4, 5, 6, 10, 20, 30, 40, 50, and 60 minutes

Verification Test Acceptance Criteria:

A verification tested nail with a 60-minute load hold at 1.50TL is acceptable if:

1) Creep rate does not exceed 0.08 inch from 1-min to 60-minutes.

2) Total movement measured at the Maximum Test Load (MTL=2.00 DTL) exceeds 80 percent of theoretical elastic elongation of the non-bonded length.

Elongation Calculations

$$\begin{aligned}
 MTL &= 34.00 \text{ kips} & Lu (\text{Unbonded Length}) &= 7 \text{ ft.} \\
 E &= 29000 \text{ ksi} & A (\text{X-Section Area}) &= 0.600 \text{ sq. in} \quad \#7 \text{ Bar} \\
 \text{Theoretical Elongation} &= 0.1559 \text{ inches} \\
 80\% \text{ Theoretical Elongation} &= 0.1247 \text{ inches} \\
 \text{Actual Elongation} &= \text{inches}
 \end{aligned}$$

Load Cell	Reading
1.70	3150
4.25	4700
8.50	8500
12.75	12300
17.00	15800
21.25	20000
25.50	22500
29.75	
34.00	
1.70	

Total Creep Movement
From 1- to 60-minutes: _____ inches